

# MJO Prediction and Teleconnections in sub-seasonal forecasts

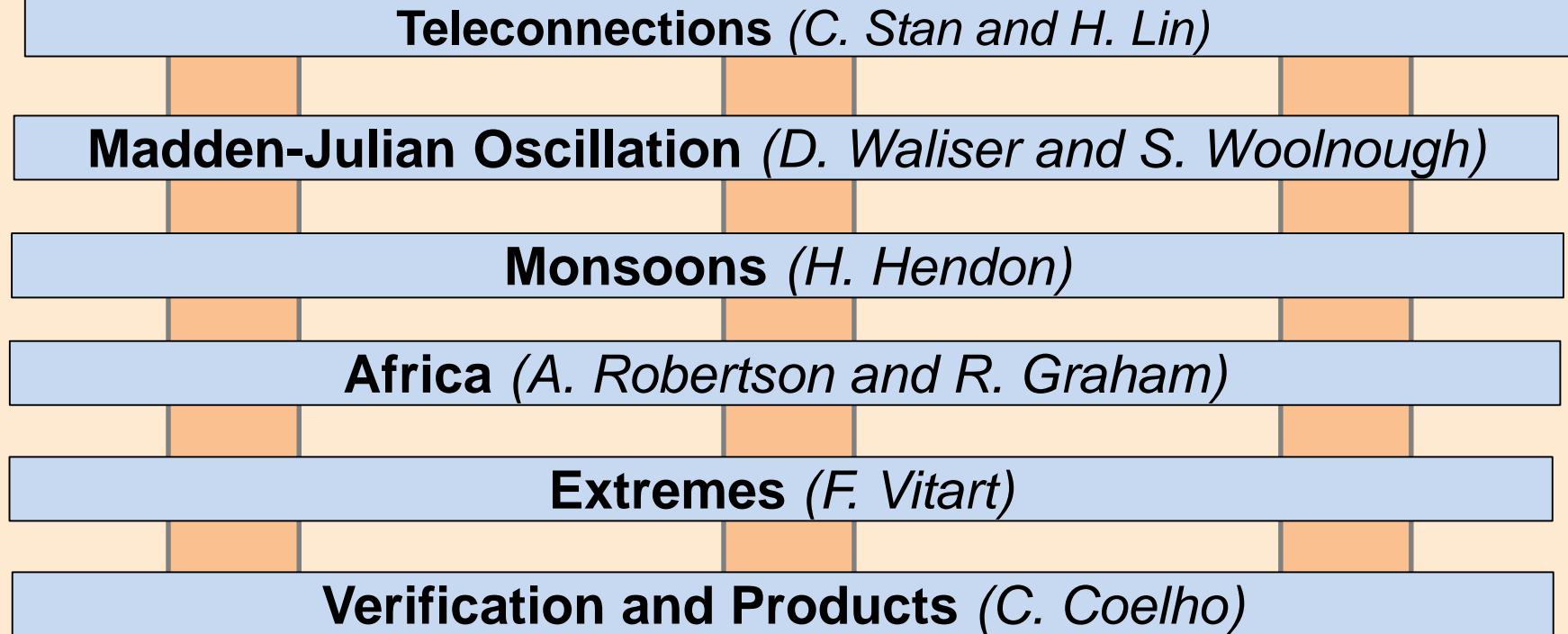
*Frédéric Vitart*

*ECMWF*

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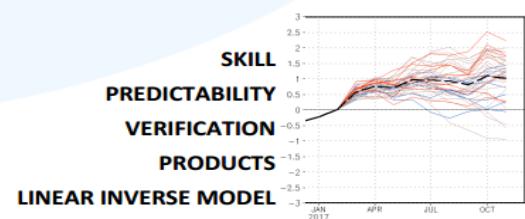
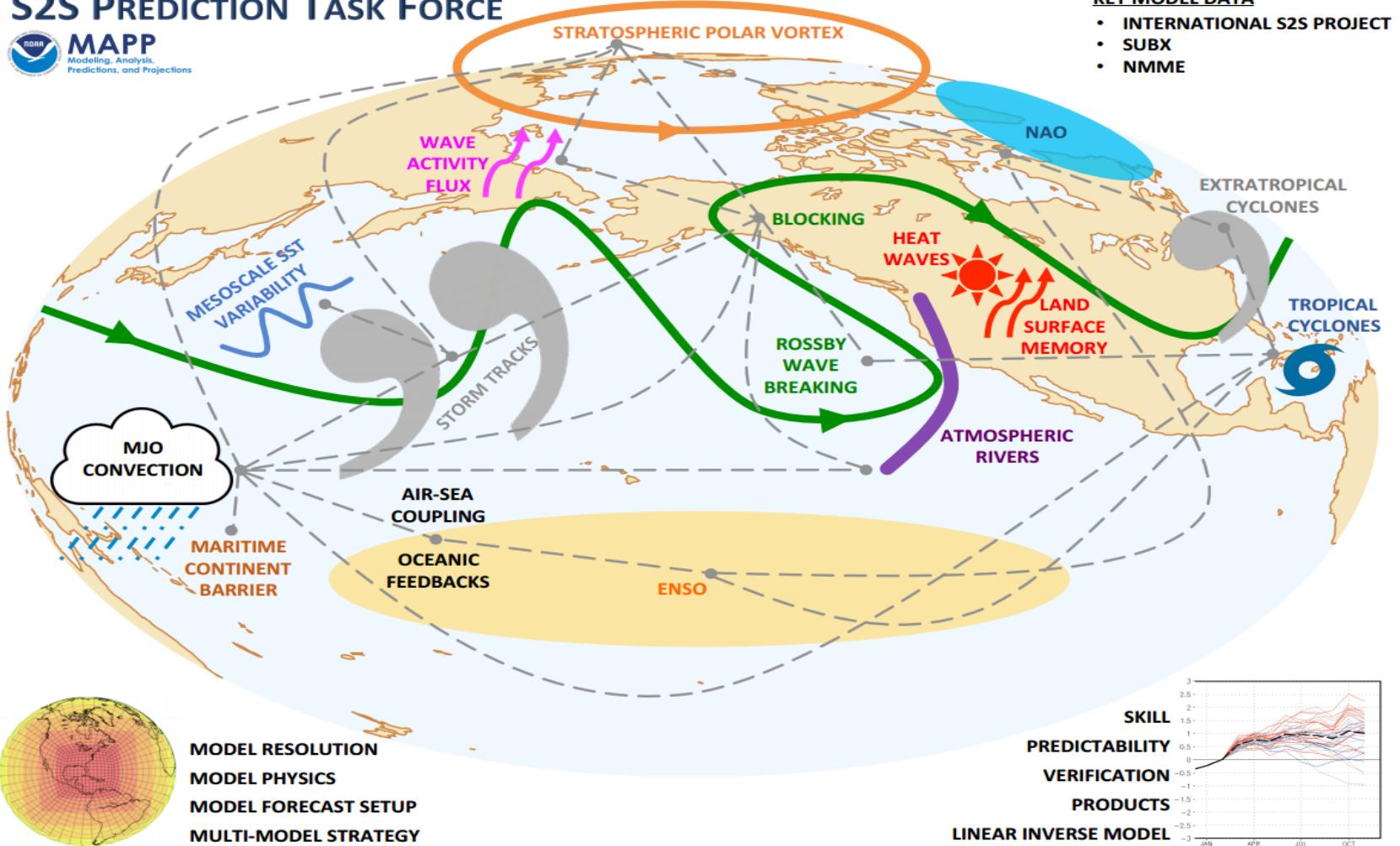
## Sub-Projects



| Research Issues  | Modelling Issues   | Needs & Applications  |
|--|--|---|
| <ul style="list-style-type: none"><li>• Predictability</li><li>• Teleconnection</li><li>• O-A Coupling</li><li>• Scale interactions</li><li>• Physical processes</li></ul> | <ul style="list-style-type: none"><li>• Initialisation</li><li>• Ensemble generation</li><li>• Resolution</li><li>• O-A Coupling</li><li>• Systematic errors</li><li>• Multi-model combination</li></ul> | Liaison with SERA<br>(Working Group on<br>Societal and Economic<br>Research Applications) |

**S2S Database**

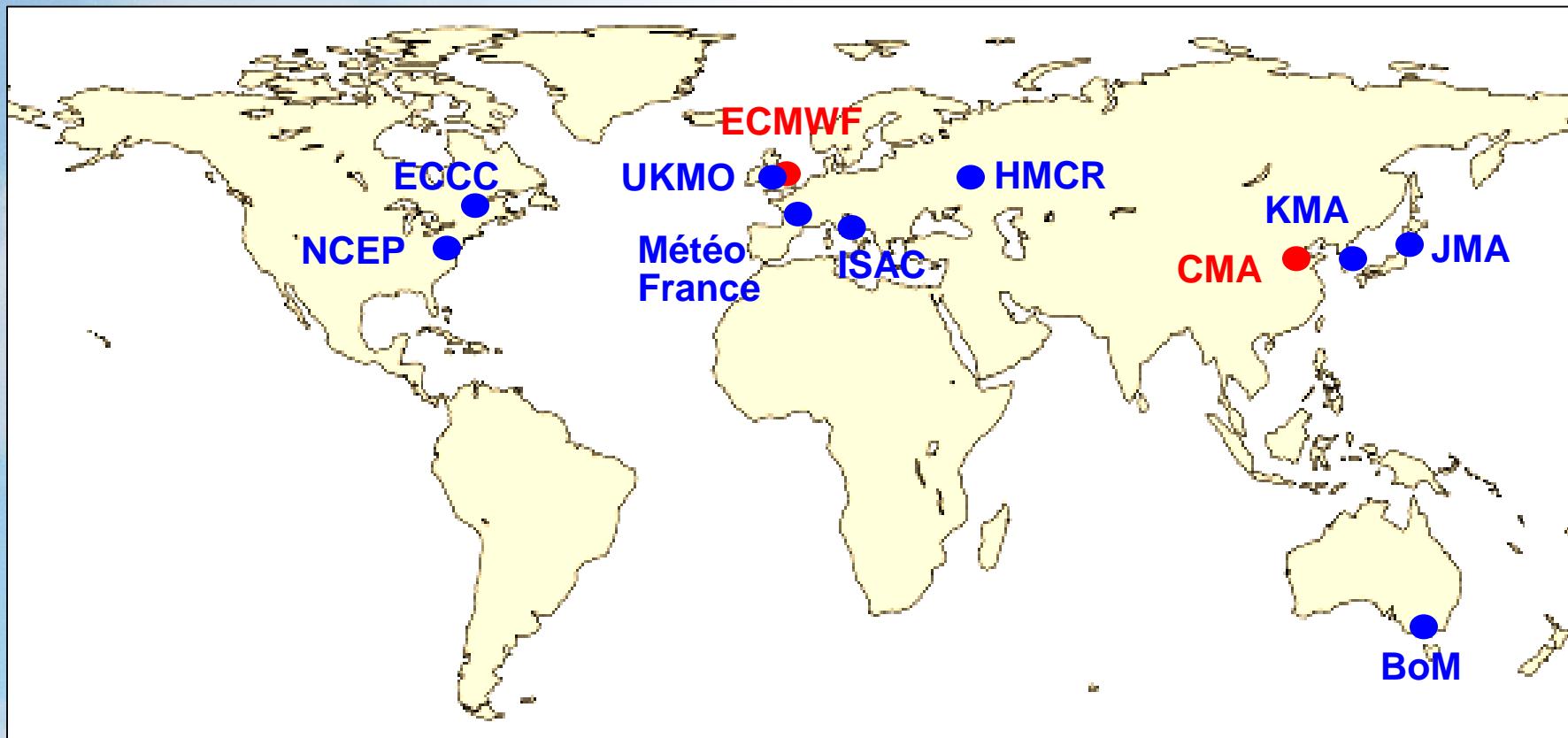
# S2S PREDICTION TASK FORCE



# Contributing Centres to S2S database

- Data provider (11)

- Archiving centre (2)



[s2s.ecmwf.int](http://s2s.ecmwf.int)

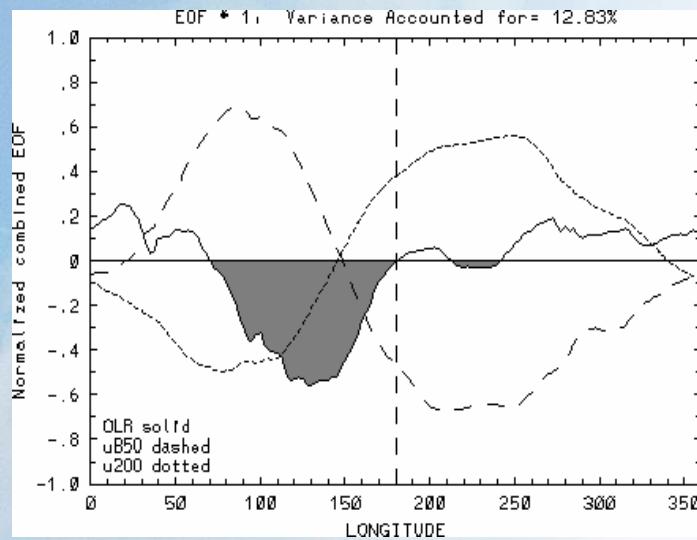
[s2s.cma.cn](http://s2s.cma.cn)

# WWRP/WCRP S2S Database

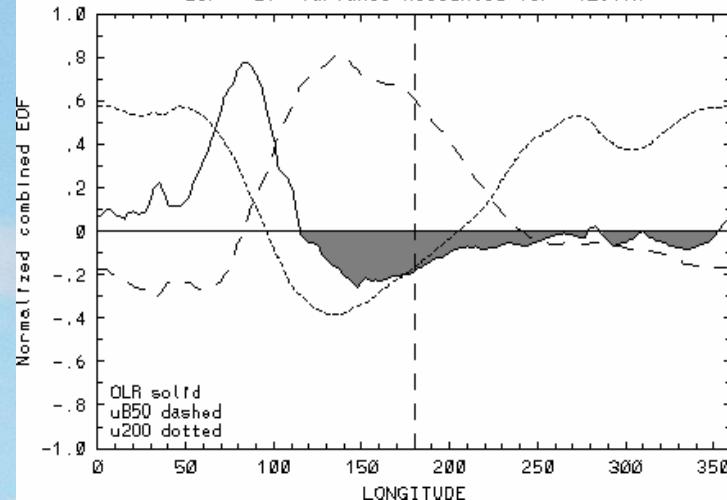
|                 | Time-range | Resol.        | Ens. Size | Freq.    | Hcsts      | Hcst length | Hcst Freq | Hcst Size |
|-----------------|------------|---------------|-----------|----------|------------|-------------|-----------|-----------|
| <b>ECMWF</b>    | D 0-46     | T639/319L91   | 51        | 2/week   | On the fly | Past 20y    | 2/weekly  | 11        |
| <b>UKMO</b>     | D 0-60     | N216L85       | 4         | daily    | On the fly | 1993-2015   | 4/month   | 3         |
| <b>NCEP</b>     | D 0-44     | N126L64       | 4         | 4/daily  | Fix        | 1999-2010   | 4/daily   | 1         |
| <b>ECCC</b>     | D 0-32     | 0.45x0.45 L40 | 21        | weekly   | On the fly | 1995-2014   | weekly    | 4         |
| <b>BoM</b>      | D 0-60     | T47L17        | 33        | 2/weekly | Fix        | 1981-2013   | 6/month   | 33        |
| <b>JMA</b>      | D 0-34     | T319L60       | 25        | 2/weekly | Fix        | 1981-2010   | 3/month   | 5         |
| <b>KMA</b>      | D 0-60     | N216L85       | 4         | daily    | On the fly | 1996-2009   | 4/month   | 3         |
| <b>CMA</b>      | D 0-45     | T106L40       | 4         | daily    | Fix        | 1986-2014   | daily     | 4         |
| <b>CNRM</b>     | D 0-32     | T255L91       | 51        | weekly   | Fix        | 1993-2014   | 2/monthly | 15        |
| <b>CNR-ISAC</b> | D 0-32     | 0.75x0.56 L54 | 40        | weekly   | Fix        | 1981-2010   | 6/month   | 1         |
| <b>HMCR</b>     | D 0-63     | 1.1x1.4 L28   | 20        | weekly   | Fix        | 1981-2010   | weekly    | 10        |

# Wheeler and Hendon MJO Index

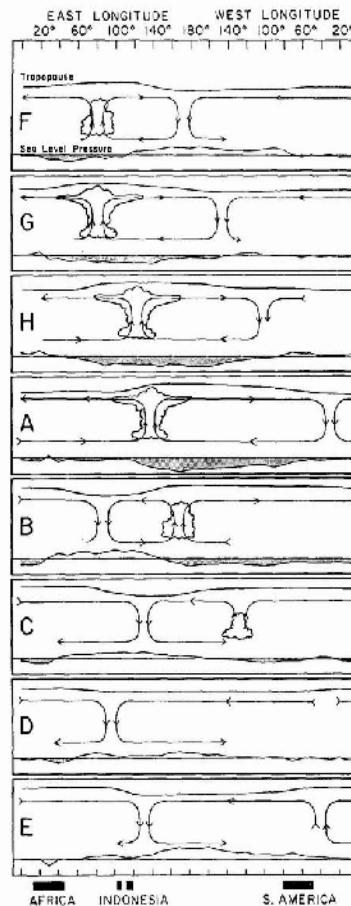
## Combined EOF1



## Combined EOF2

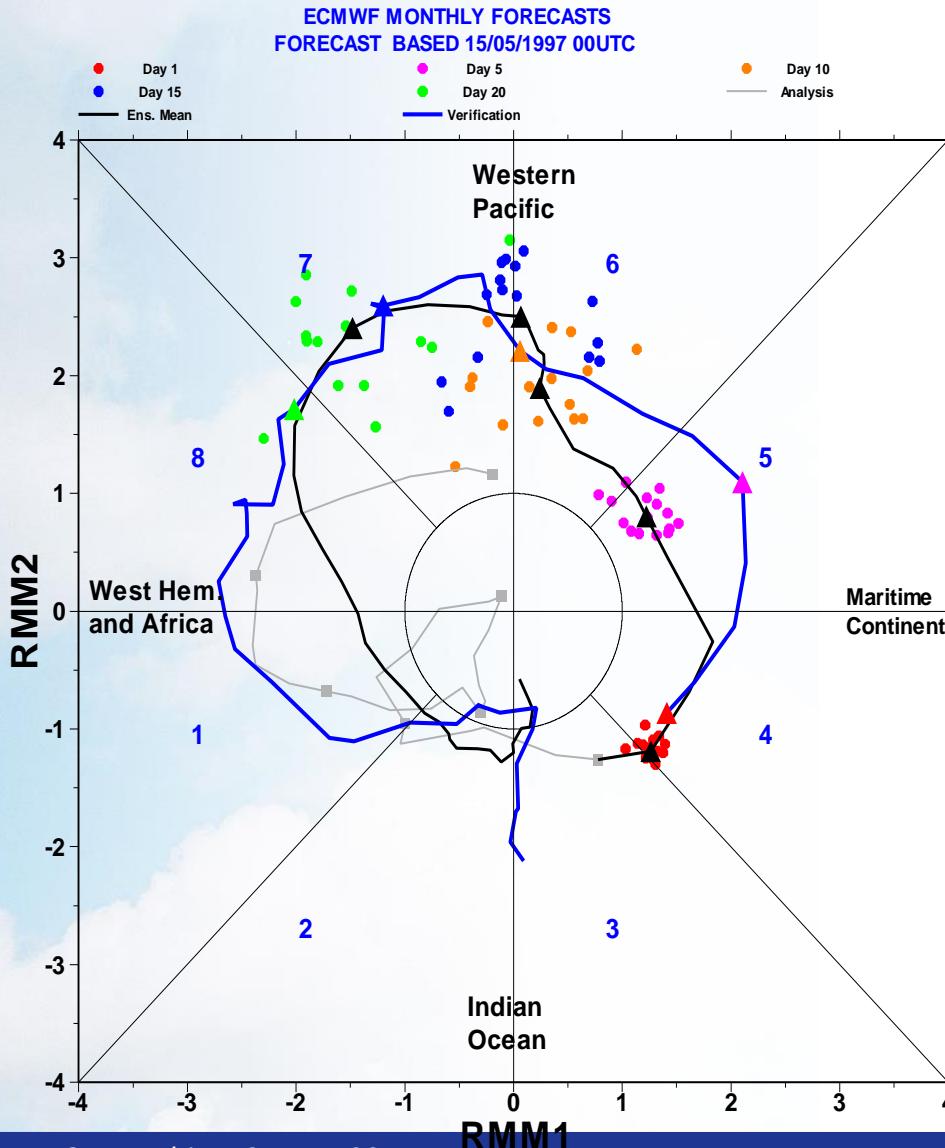


Madden and Julian's (1972) schematic



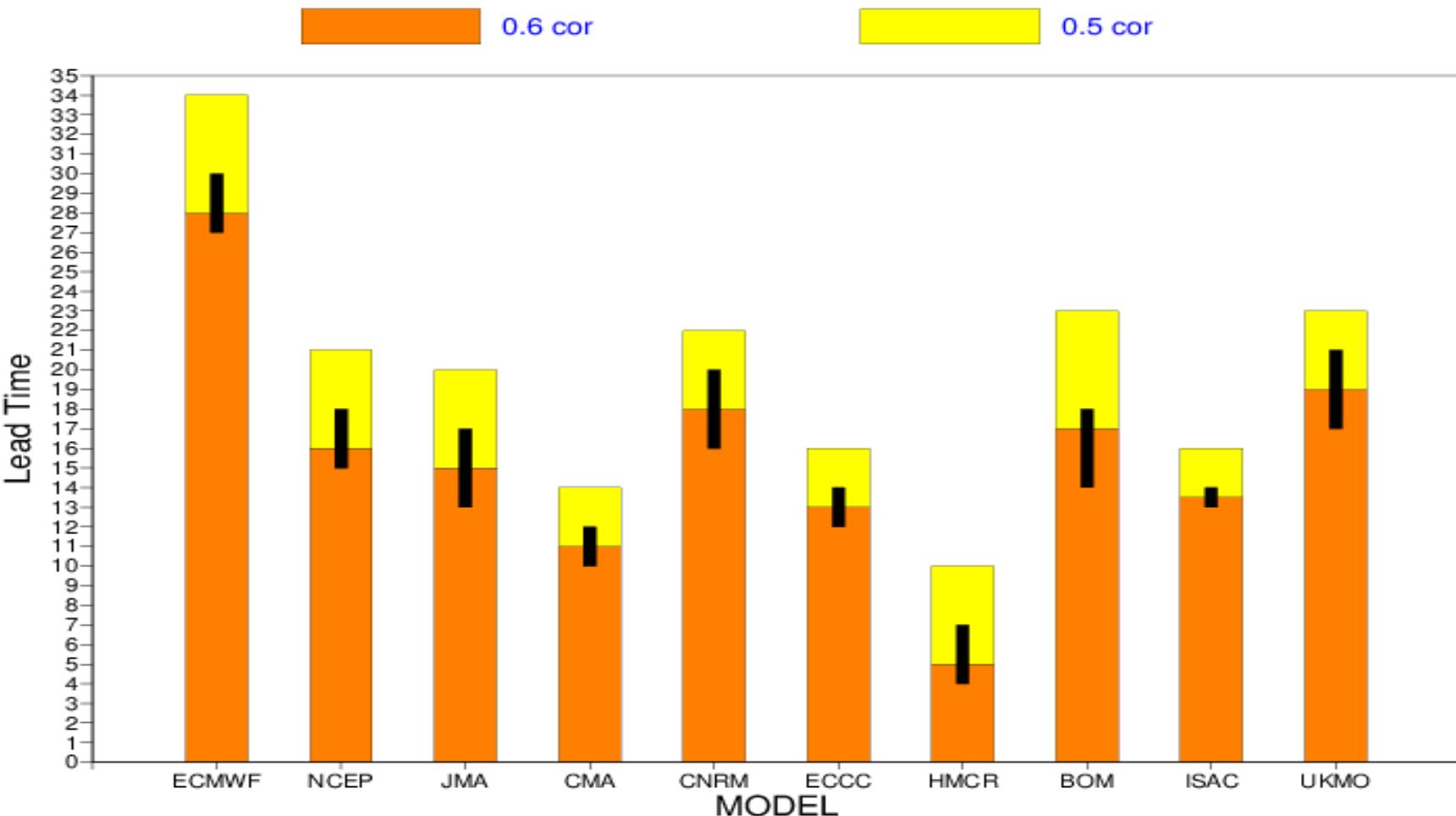
From Wheeler and Hendon, BMRC

# MJO FORECAST



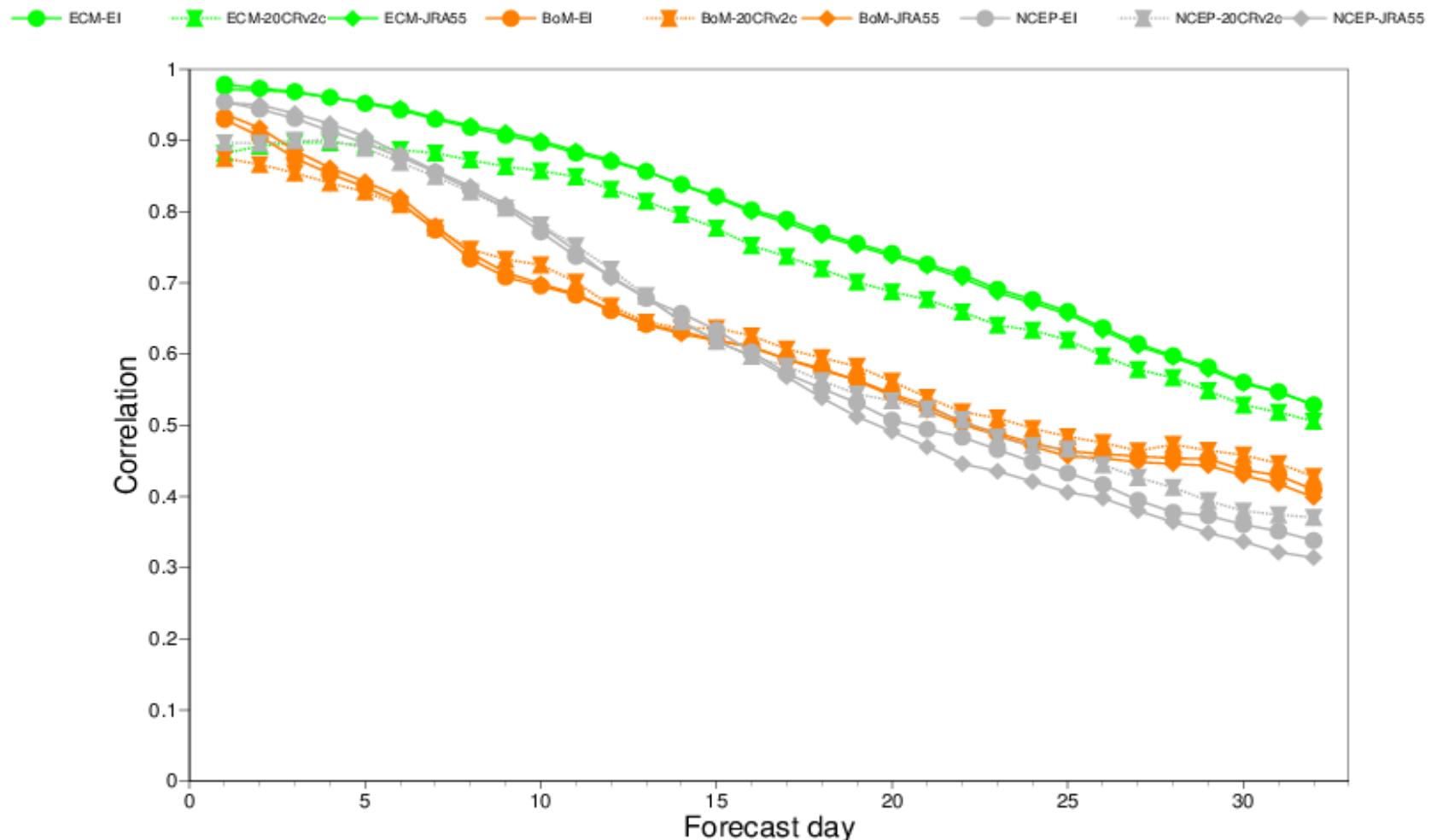
# Bivariate Correlation with ERA Interim – Ensemble Mean 1999-2010 re-forecasts

MJO Bivariate Correlation  
S2S REFORECASTS 1999-2010



# Impact of the choice of the verification re-analysis

MJO Bivariate Correlation 1999-2010 re-forecasts

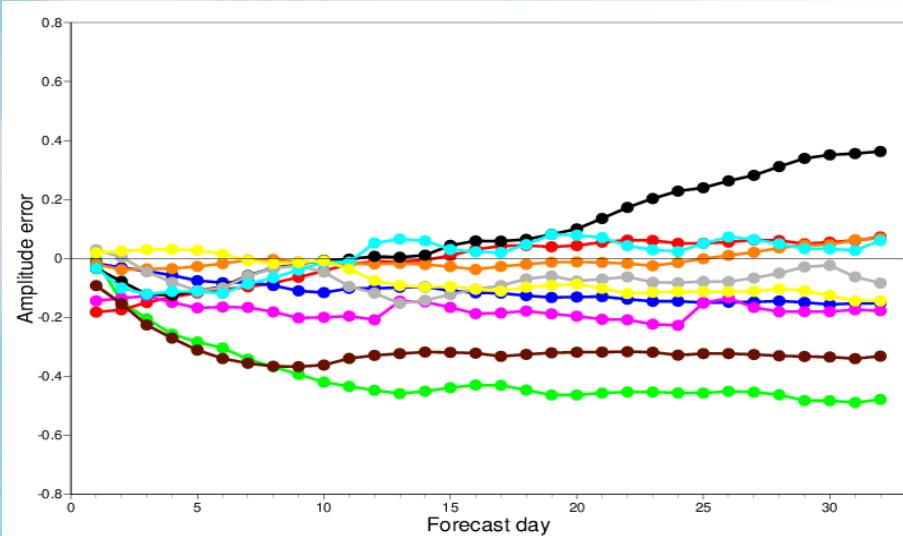


# MJO - 1999-2010 re-forecasts

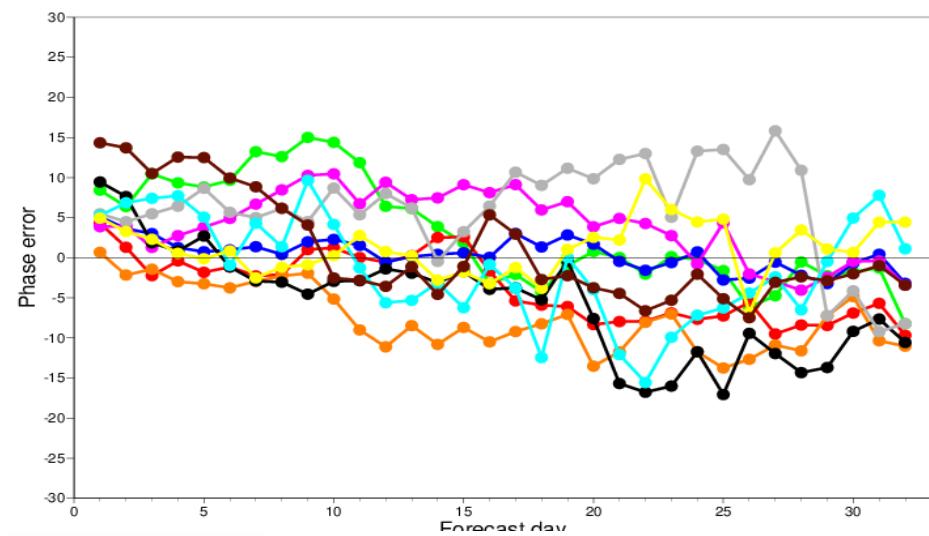
Legend:

- JMA (green circle)
- BoM (red circle)
- ECMWF (blue circle)
- NCEP (orange circle)
- CMA (magenta circle)
- CNRM (black circle)
- UKMO (grey circle)
- EC (cyan circle)
- ISAC (yellow circle)
- HMCR (dark red circle)

Amplitude error relative to ERA Interim

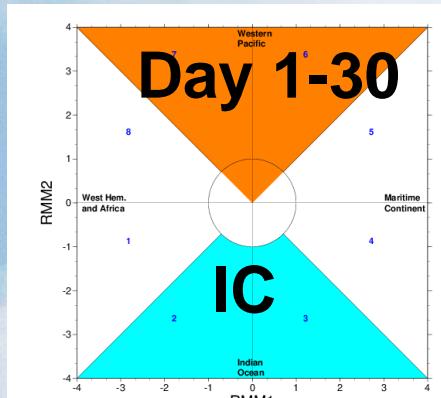


Phase error relative to ERA Interim

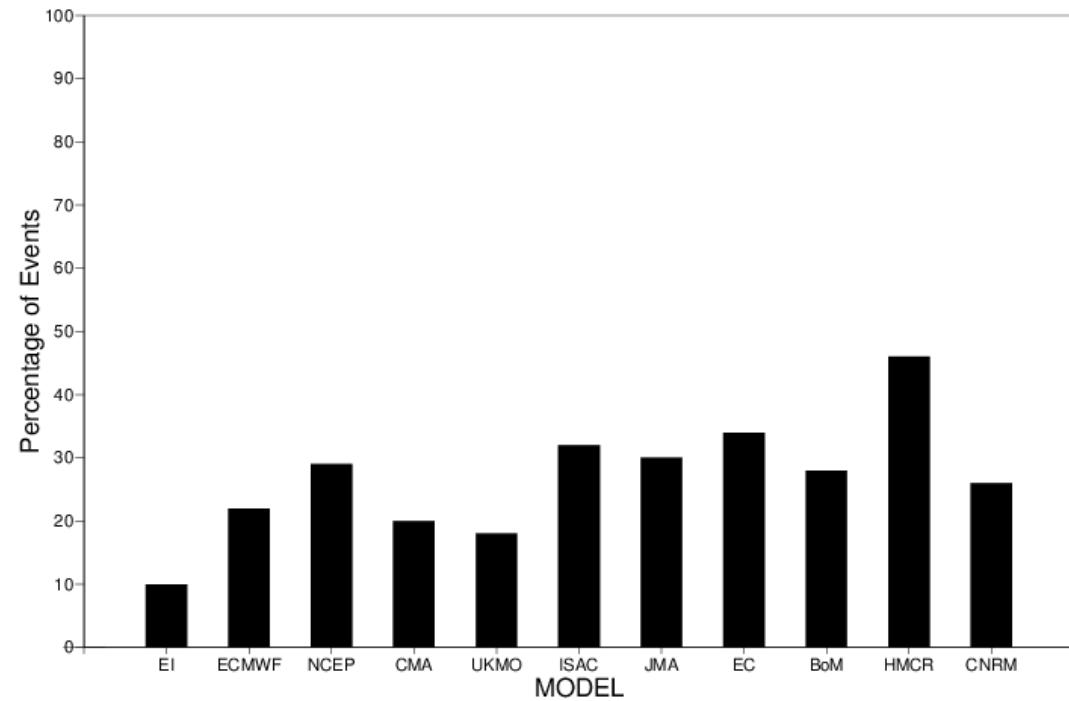


**MJO generally too weak and too slow compared to ERA Interim**

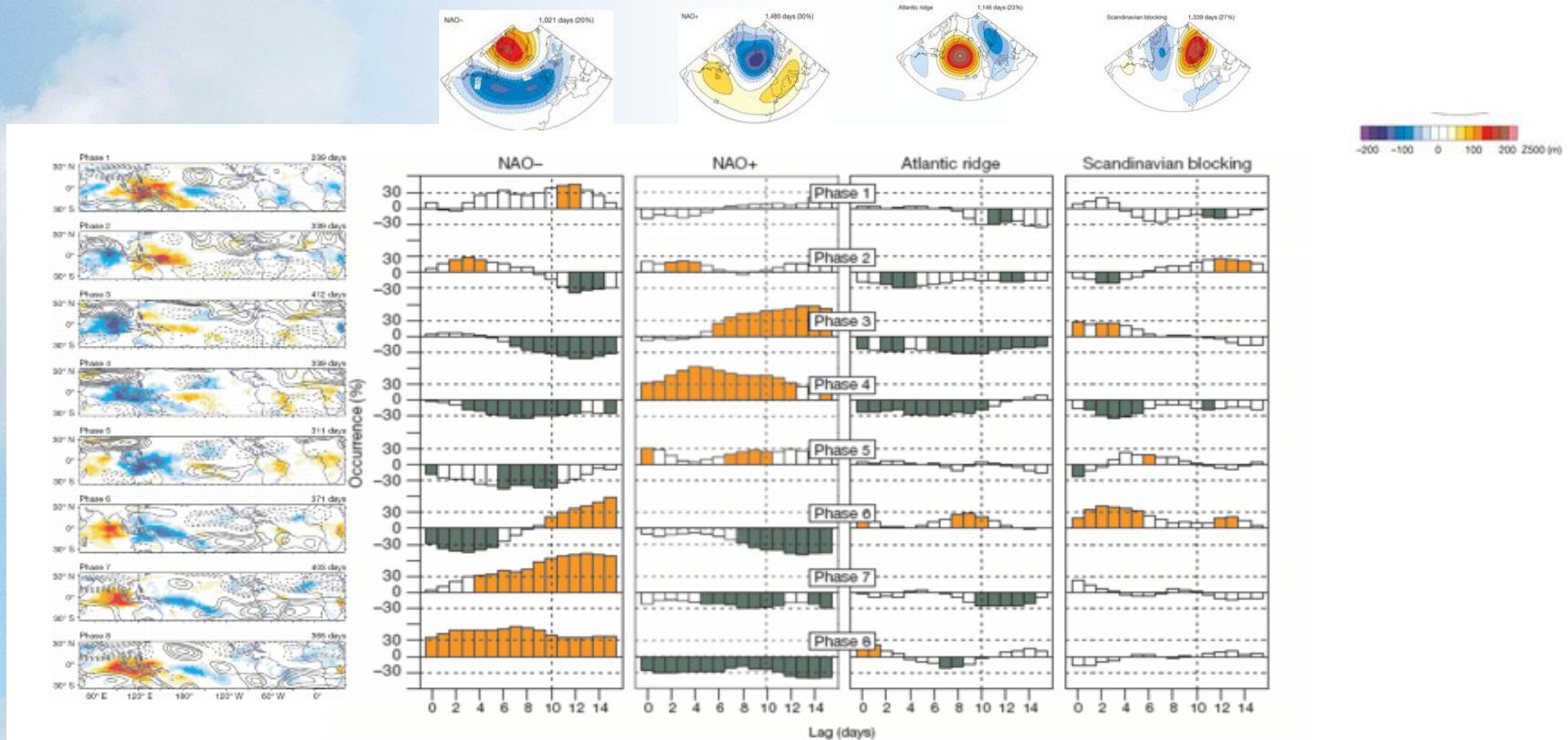
# Maritime Continent crossing



Percentage not crossing the MC  
S2S REFORECASTS DJFM 1999-2010



# Impact of the MJO on weather regimes



Cassou C, 2008: Intraseasonal interaction between the Madden-Julian Oscillation and the North Atlantic Oscillation. *Nature*, **455**, 523-527.

Cassou (2008)

# Composites of Z500 3rd pentads after an MJO in Phase 3 NDJFM

EI 0.48

NAO Index: mean=0,  
std=1.02



BoM 0.15

CMA 0.14

HMCR 0.13

NCEP 0.32

ISAC 0.25

CNRM 0.15

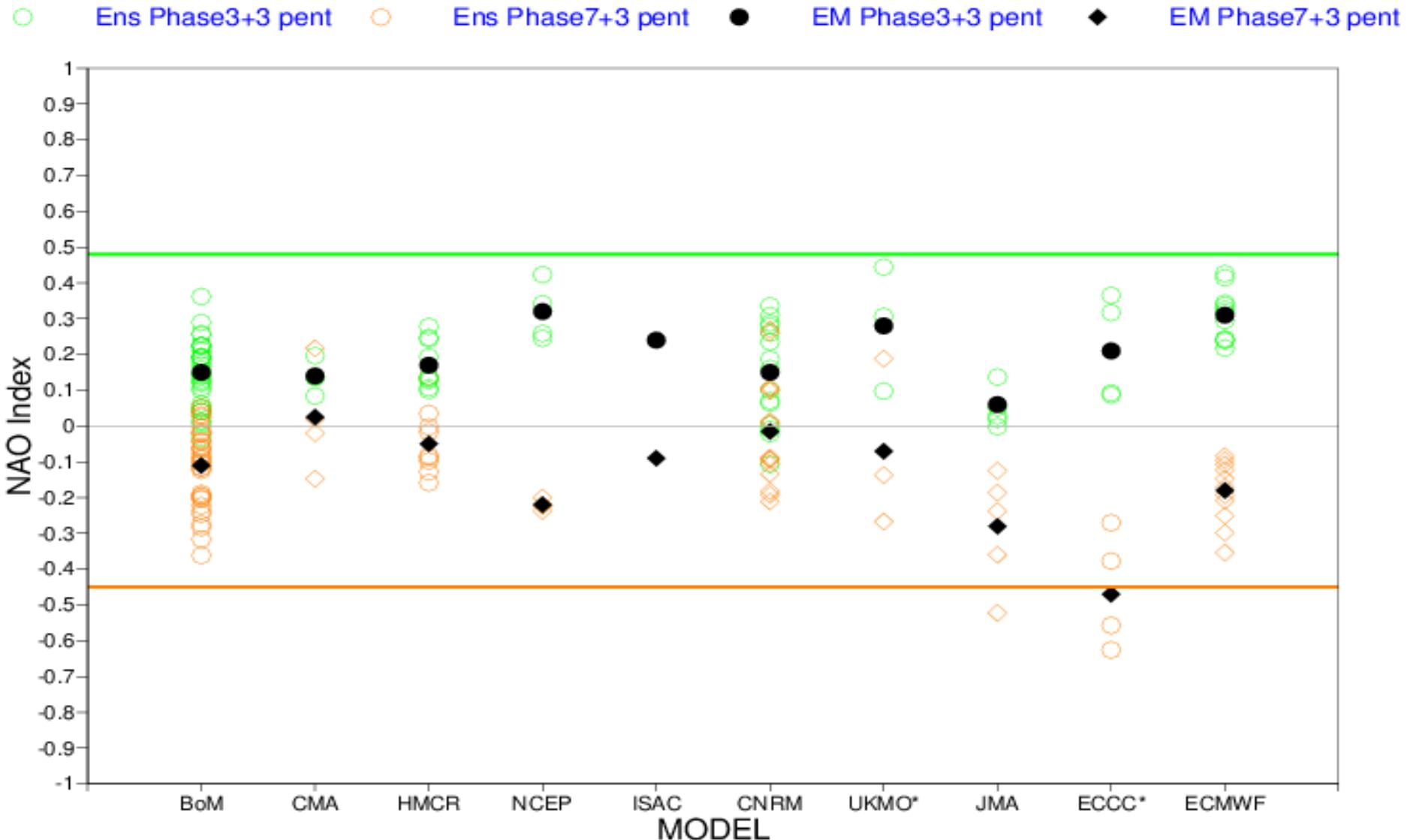
UKMO 0.28

JMA 0.22

ECCC 0.21

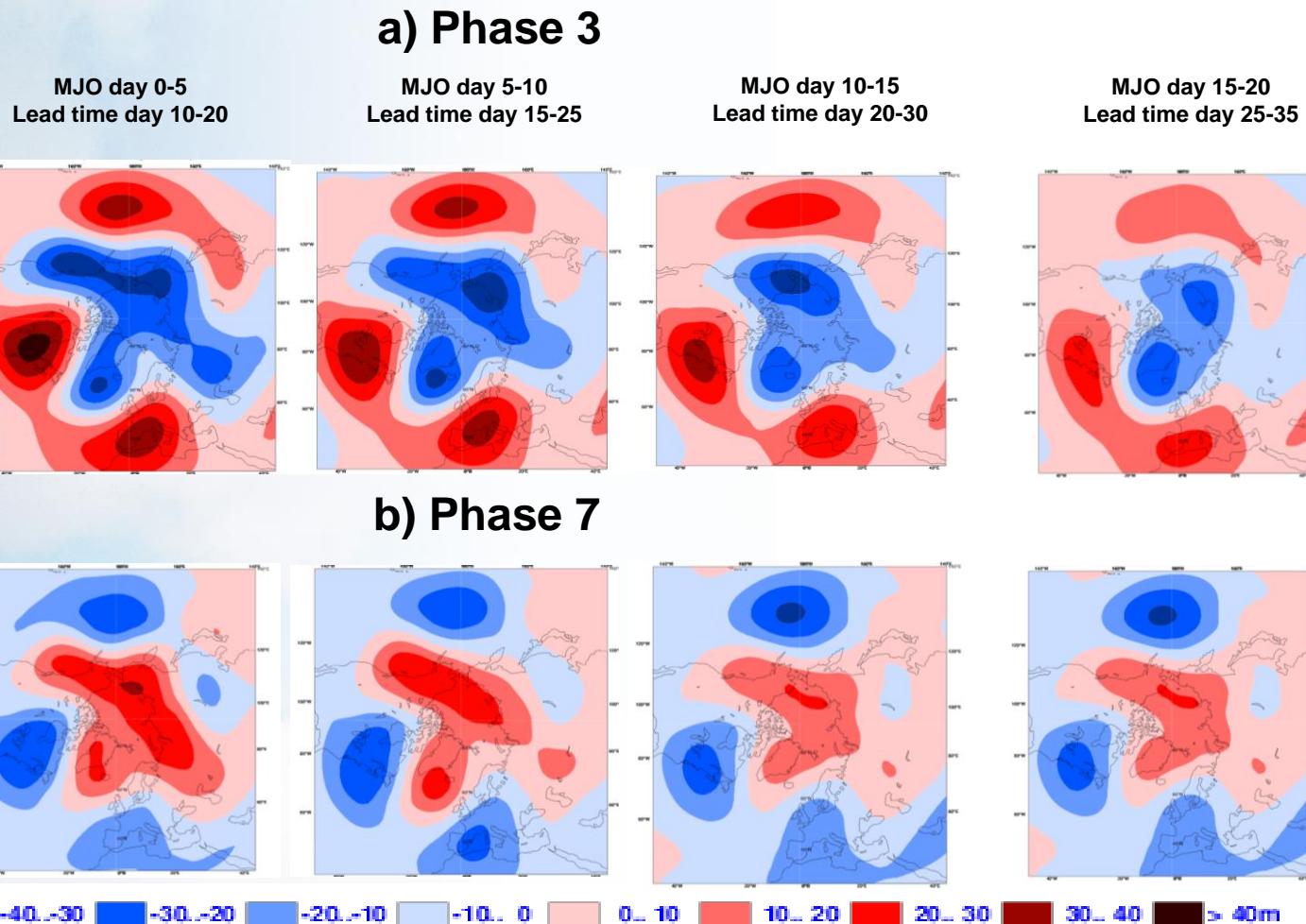
ECMWF 0.31

# NAO Index S2S REFORECASTS 1999-2010



# Evolution of Teleconnection with lead time –MJO Phase 3 and 7

ERA  
Interim



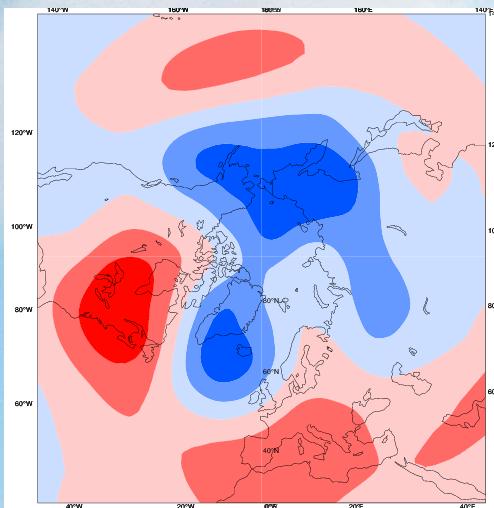
# Tropical relaxation experiment

15 member ensembles running on 1<sup>st</sup> NDJFM 1989-2015 for 46 days

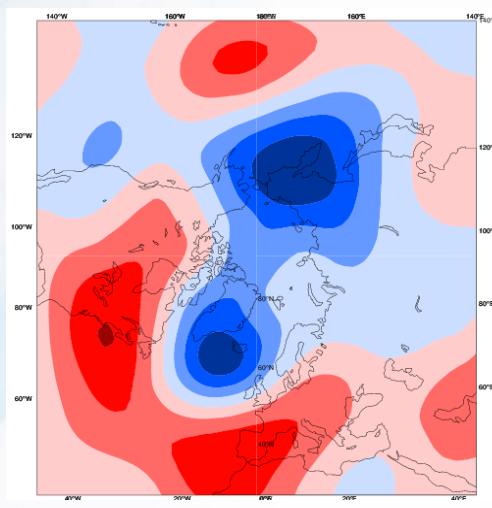
Control: IFS CY43R1

Relaxation: Tropical band 20N-20S relaxed towards ERA Interim

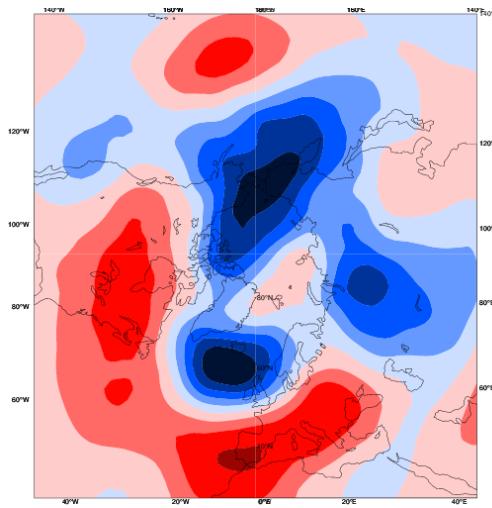
Control



Relaxation

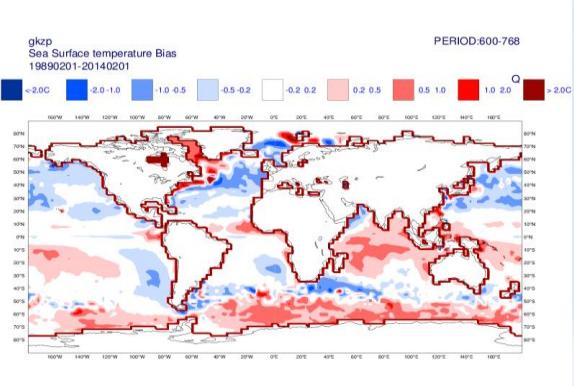


ERA Interim

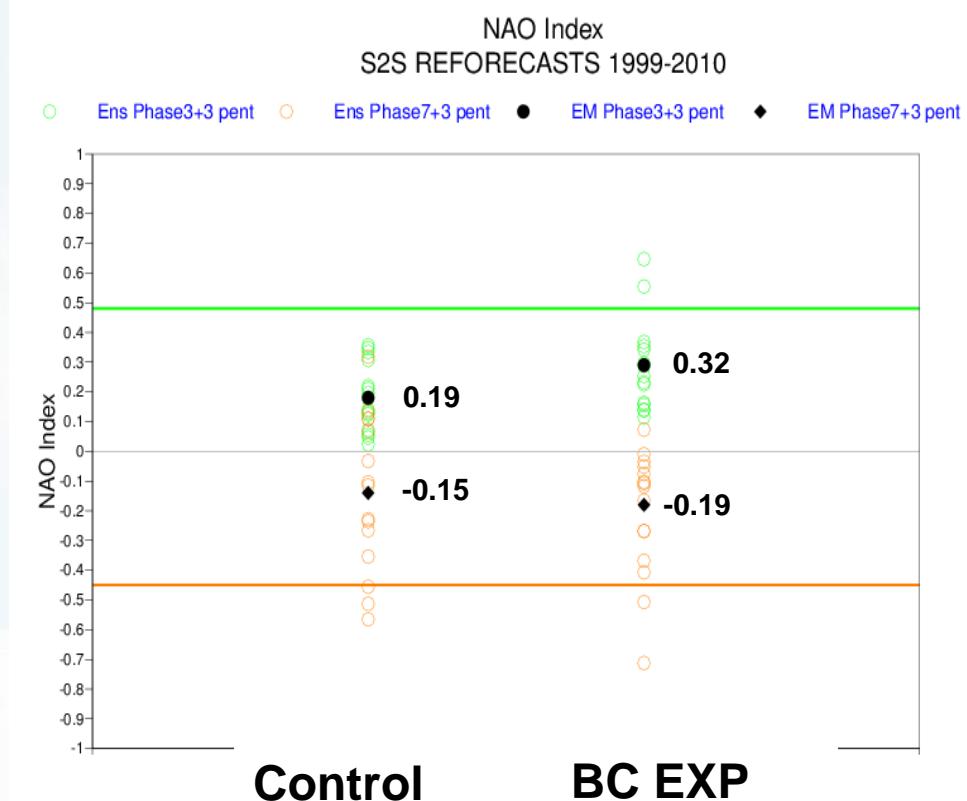
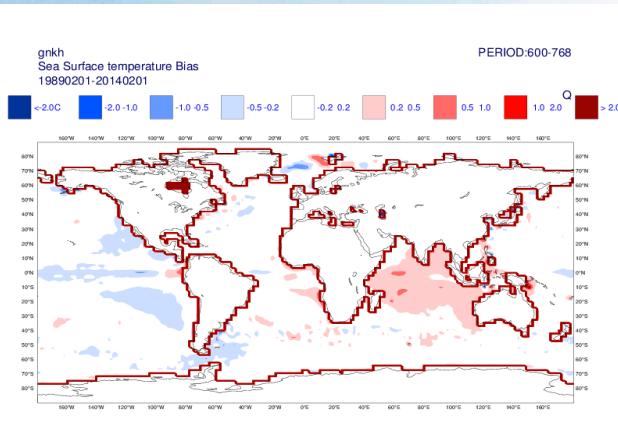


# Impact of SST biases

## Control



## BC experiment



# Conclusions

- S2S models show skill to predict the evolution of the MJO up to 5 weeks in advance.
- MJOs tend to get too slow and weak in the extended range forecasts
- S2S models are able to represent the general patterns of MJO teleconnections in the Extratropics, but the amplitude in the Euro-Atlantic sector is too weak.
- The realism of teleconnections decreases quickly with lead time
- Atmospheric resolution and ocean/atmosphere coupling may impact the amplitude of the MJO teleconnections.